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TECHNICAL REPORT
69-75-GP

TEST REPORT:

BIAXIAL TENSILE TESTS OF COATED FABRICS

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U.S. Army Natick Laboratories

Contract No. DA-19-129-AMC-1042(N)

May 1969

UNITED STATES ARMY
NATICK LABORATORIES

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FOREWORD

This report was prepared by Fabric Research Laboratories, Inc. under U. S. Army Contract No. DA-19-129-AMC-1042(N). Results of earlier work under this contract have been previously reported and distributed as Technical Report 67-71-GP of the General Equipment & Packaging Laboratory, U. S. Army Natick Laboratories. The work was done under the direction of the U. S. Army Natick Laboratories, with Mr. Constantin J. Monego acting as project engineer.

Dr. M. M. Platt was the Fabric Research Laboratories' officer responsible for the contract. The biaxial tensile test machine was designed by Mr. R. E. Sebring. Fabric testing and data reduction were performed by Mrs. Meredith M. Schoppee and Mr. Rolf A. Frantz, Jr.; Mr. W. D. Freeston, Jr. performed the theoretical portion of the biaxial stress-strain of fabrics.

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ABSTRACT

This report discusses the design, operation, and purpose of a new biaxial test instrument that was constructed by the Fabric Research Laboratories of Dedham, Massachusetts, for the U. S. Army Natick Laboratories, a subordinate activity of the U. S. Army Materiel Command.

The report also presents the stress-strain test results on three air-supported tent fabrics performed with the new test instrument. A correlation and comparison is made between these data and previous work performed with other tensile test equipment.

The AMC biaxial test instrument was found to be suitable for measuring the mechanical response of fabrics under a biaxial load ratio of 1:1, as in spherical air-supported structures, and a biaxial load ratio of 1:2, as in cylindrical air-supported structures.

TEST REPORT: BIAXIAL TENSILE TESTS OF COATED FABRICS

INTRODUCTION

The present system of controlling the strength of fabrics by uniaxial breaking strength tests does not adequately define the behavior of the fabric in an air-supported shelter. A fabric in an air-supported shelter is under constant stress in all directions. In a textile structure where yarns are interlocked in orthogonal directions, the stress in the fabric is oriented along the directions of the warp yarns and the filling yarns which are at right angles to each other. The simultaneous orthogonal stress distribution is termed "biaxial stress". The strength of a fabric for air-supported tents must be evaluated under biaxial stress-strain conditions in order to predict its usefulness in this type of structure. The specification of strength of a fabric alone is not sufficient for a mechanical fabric under constant stress, as it is for a fabric in an air-supported shelter. What is needed is data on the stress-strain relationship of a fabric under actual use conditions, i.e., biaxial stress-strain at a loading ratio of 1:1 for a sphere and 1:2 for a cylinder. There was no instrument to measure the biaxial stress-strain behavior of fabrics and an instrument had to be developed. An instrument was built by the Fabric Research Laboratories under contract with the U. S. Army Natick Laboratories, a subordinate activity of U. S. Army Materiel Command. This report discusses for the first time the use of this instrument in testing military fabrics currently specified for air-supported structures. The ultimate objective of this testing is to provide the information required on the mechanical response of the fabric (stress-strain) to the geometry of structure, i.e., 1:1 biaxial stress-strain ratio for a spherical shelter, and a 1:2 biaxial stress-strain ratio for cylindrical shelters.

SAMPLES TESTED

Samples of three different coated fabrics, which are typical examples of the materials currently used for the construction of air-supported tents and other inflated structures, were furnished by the U. S. Government for evaluation on the new AMC biaxial tensile tester (Figure 1*). The objective of these tests was twofold: (1) determination of the biaxial tensile response of the fabrics; (2) demonstration of the performance of the test apparatus. Where possible, direct comparisons are made between the results of the tests performed with the apparatus developed under this program and comparable tests performed on the same fabrics with other instruments.

The three fabrics include a lightweight, 2.6-oz/sq yd, polyurethane-coated nylon fabric; a heavy, vinyl-coated nylon fabric weighing 18.3 oz/sq yd; and a neoprene- and Hypalon-coated polyester fabric weighing 13.8 oz/sq yd. Further description of the fabrics is given in Table I*.

*Figures and tables are at the end of this report.

As noted in this table, the construction of the polyurethane-coated nylon fabric is not square, i.e., there are approximately twice as many warp yarns per inch as filling yarns. The construction of the other two fabrics is approximately square.

DESCRIPTION OF THE TEST INSTRUMENT

The AMC Biaxial Tensile Test Machine for fabrics is an apparatus for applying tension loads to cruciform fabric or sheet material specimens in two orthogonal directions at the same time. The machine design includes provisions for controlling the magnitudes and ratio of the loads in the two directions, and instrumentation for measuring the applied loads and specimen elongations.

The tester is equipped with both a photographic and a photoelectric system for measuring specimen elongation in both principal directions. A camera may be used to obtain intermittent photographs of the changing dimensions of targets drawn on the specimen. Or, an electronic strain-measuring system (Allied Research Associates Digitape dynamic displacement transducer), consisting of a photoelectric cell and graduated transparent tape as an unbonded strain gauge, may be used to obtain an autographic record of fabric elongation.

Sensitivity of the photoelectric strain transducers is dependent on the fineness and the precision of graduations on the phototape. With tape having a grid width of 0.002 inch, there is a sensitivity of ± 0.002 inch in a 2-inch gauge length, or 0.1% elongation. With coarser graduations, this sensitivity is reduced. The selection of an appropriate tape is determined by expected performance of the specimens to be tested. A small total elongation requires a fine tape graduation, and a large elongation requires a coarser graduation. The overall limitation on the measurement sensitivity is determined by the chart recorder. Since the strain measurement output is displayed as a series of pulses, the number of pulses per unit chart length must be limited so that individual peaks or pips* are discernible, and also so that the pen response capability of the recorder is not exceeded.

The load cells used in the force-measuring system have a nominal 1000-pound, full-scale range. They have the capacity to withstand a 150% overload with no deterioration in performance, and a 300% overload with no mechanical damage. Maximum terminal nonlinearity is ± 0.1% of full scale. Maximum hysteresis is ± 0.05% of full scale. Repeatability is within ± 0.05% of full scale.

*Individual peaks of recorded fabric strain are shown in Figure 2.

Rate of loading is controlled manually by the operator, who manipulates the air pressure regulator valve to maintain a linear force-versus-time relationship on the chart recorder. The range of testing speeds available is dependent on the operator, the machine design, and on the properties of the material being tested. Maximum speed is approximately zero to 1000 lb in 10 seconds; slow speeds of zero to 100 lb in 10 minutes or longer can be obtained.

EXPERIMENTAL PROCEDURE

Biaxial tensile loads in the fabric are generated by the motions of four orthogonally aligned jaws which grasp the tails of a cruciform specimen. The specimens are cut so that the tails of the cruciform are aligned with the warp and filling directions of the fabric and mounted in the tester so that the warp and filling directions correspond to the x and y machine directions, respectively. Specimens with overall dimensions of 17 inches by 10 inches were used. The jaws can accommodate tail widths up to 4 inches.

The polyurethane-coated nylon fabric and the neoprene- and Hypalon-coated polyester fabrics were tested using 4-inch tail widths (thereby giving 4-inch-square biaxial fields); the specimens were gripped in serrated, metal-faced jaws lined with the vinyl-coated nylon fabric. The vinyl-coated nylon fabric was tested using 2-inch tail widths (2-inch-square biaxial fields); the jaws were lined with a coarse-weave fiberglas fabric.

The yarn bow and skew is so severe in some sections of the vinyl-coated nylon fabric and the neoprene- and Hypalon-coated polyester fabric that it is not possible to cut a 2-inch wide, orthogonal cruciform test specimen which contains any through-going yarns in the filling direction. The skew in the polyurethane-coated nylon fabric is not severe. All specimens were prepared by cutting along parallel yarns, thereby resulting in test specimens with moderately or extremely bowed tails.

The specimens were carefully mounted in the machine without distortion in the central region, and centered on the principal axes of the machine to promote equal load distribution across the width of the specimen tails. Measurements of biaxial strains were made in the center portion of the biaxial force field. Two-inch long gauge lengths were used on specimens with 4-inch wide tails, and one-inch long gauge lengths on specimens with 2-inch wide tails.

Some experience and proficiency on the part of the operator is necessary for proper operation of the equipment. It is desirable that the onset of loading in both the x and y directions should occur at exactly the same point in time. To achieve this it is necessary to adjust the initial slack in the specimen so that when the load application begins, the specimen tails are nei r slack nor extended.

When the photoelectric strain gauge is used as a measuring device, there is sometimes some difficulty in determining initiation of fabric extension. This is because of differences in the relative initial tension or slack in the specimen and in the unbonded strain gauge tape. If the tape is more slack than the specimen, it does not indicate any motion until the specimen has extended sufficiently to remove the slack; similarly, if the tape is more taut than the specimen, several grid marks may pass through the photocell, indicating false elongation, before actual fabric elongation occurs. A careful test set up by the operator minimizes these effects. This problem is not encountered when using the photographic technique for strain measurement since the initial photograph shows the fabric in an unloaded state.

The procedure used to obtain a load-elongation diagram from the autographic output of the load- and strain-measuring transducers is as follows (refer to Figure 2):

1. Determine the zero elongation position, i.e., the point at which a cyclic output from the photocell begins.

2. Select an appropriate elongation interval at which to plot values of load. Usually 5 to 15 points, depending on the load and elongation scales being used, are sufficient to specify the load-elongation curve.

3. Mark off pips at the d ined elongation intervals as shown in Figure 2.

   $$\frac{\%\ \text{strain}}{\text{pip cycle}} = \frac{0.\text{C}}{} \cdot \frac{\text{nes per complete pip cycle}}{\text{0 inches gauge length}} \times 100$$

   $$= \quad \text{er pip cycle}$$

4. Measure backw long the time axis from each marked pip 0.14 inch for put from the x-axis recorder and 0.11 inch for output from the y-axis recorder. Transfer the point on the time axis to the load curve. (The pen that records strain data is located behind the pen that records load so that the motion of one will not interfere with the motion of the other. Therefore, simultaneous conditions of load and elongation in the sample are not recorded at the same distance along the time axis of the chart.)

5. Record load values at particular elongation levels. Divide these loads read from the chart by the sample tail width to obtain load in lb/inch of sample width. (See Table III.)

6. Plot load in lb/inch width versus percent elongation.

7. Average strain rate $= \dfrac{28\% \times 2.0 \dfrac{\text{inches}}{\text{min}} \text{ chart speed}}{4.56 \text{ chart inches}}$

$= 12.3\%/\text{min}$

8. Average loading rate $= \dfrac{99.0 \text{ lb} \times 2.0 \dfrac{\text{inches}}{\text{min}} \text{ chart speed}}{4.0 \text{ inches tail width} \times 4.63 \text{ chart inches}}$

$= \dfrac{10.7 \text{ lb/inch width}}{\text{min}}$

The procedure used for reducing the photographic strain data is as follows. The target photographs are projected on the screen of a microfilm reader. The length of the target image on the screen is measured with a steel rule. Two readings are taken in each of the two principal directions on each photograph and averaged. Measurements are approximated to the nearest 0.01 inch. Pairs of similar readings from each photograph usually agree within $\pm$ 0.02 inch. Differences in the dimensions of the target area in successive frames are converted to percent fabric elongation.

TEST RESULTS

In order to check the accuracy of the photoelectric method of measuring fabric strain, a biaxial test was run on the 2.6-oz/sq yd polyurethane-coated nylon fabric at a loading ratio of 1:1 (equal load levels in the warp and filling directions throughout the test) in which both photographs were taken and the strain transducers used. The load-elongation diagram obtained from this test is given in Figure 3. It illustrates the good correlation obtained with the two measuring systems.

The uniaxial tensile properties in both the warp and filling directions of the three coated fabrics are given in Table II. As noted, the polyurethane-coated nylon fabric was tensile-tested uniaxially using both the new AMC biaxial tensile tester and a standard Instron tensile test machine. The average load-elongation diagrams obtained are given in Figure 4. One set of curves is for the data obtained with the new AMC biaxial tester and the other is for the data obtained with the standard Instron tester. As shown, the correlation between the results obtained using the two test methods is generally good, with the greatest difference evidenced near the end point, at rupture.

The average biaxial load-elongation diagrams of the polyurethane-coated nylon fabric at a 1:1 loading ratio and several rates of loading are given in Figure 5. At each rate of loading, the x-direction load was increased at an approximately constant rate with respect to time; y-direction load and x- and y-direction strains were dependent variables. In the conventional uniaxial test, the specimen is elongated at a controlled rate; the resulting tensile load is the dependent variable. In order to provide a common ground for comparison of rates of testing, an equivalent (average) strain rate is calculated from the biaxial test results (see Experimental Procedure). The resulting strain rates are expressed as percent strain per minute (strain measured in the biaxially loaded zone).

For the results presented in Figure 5, test specimen elongations were determined with the photoelectric strain gauge. The strain rates in the warp and filling directions differ considerably because of the crimp unbalance and unequal number of ends in the two directions in the fabric.

The two testing speeds at which the fabric was tested are not sufficiently different to show any significant difference in material response. Although the AMC biaxial tensile tester can be operated somewhat faster than in these tests, and also considerably slower, it is not particularly suited for evaluating rate-of-loading effects. Significant rate effects on the tensile response of polymeric materials are evident only at testing speeds considerably higher than the capabilities of the present biaxial tensile test machine. High speed biaxial testing would introduce new problems in operations, control, and measurements, requiring an entirely different instrument design.

Average biaxial load-elongation diagrams of the polyurethane-coated nylon fabric are given in Figure 6 for 1:1, 2:1, and 6:1 loading ratios. The uniaxial warp and filling load-elongation diagrams of the fabric are also given in this figure. The sequence of the digits in the load ratio gives the ratio of the load level prevailing in the master cylinder direction of the biaxial tester to that in the slave cylinder direction. For this series of tests, the fabric test specimens were installed with the warp yarns running in the master direction; therefore, a designation of warp, 2:1, indicates the load-elongation response of the fabric in the warp direction, with the load acting in the warp direction twice that in the filling direction. Similarly, a test designation of filling, 6:1, indicates that that curve gives the load-elongation response of the fabric in the filling direction, with the load acting in the warp direction six times that in the filling direction.

The results given in Figure 6 show how the presence and magnitude of a transverse tensile load affect the tensile response of the fabric. Also as shown, the warp load-elongation diagrams approach the uniaxial warp load-elongation diagram with increasing loading ratio. Additional data could be generated by performing tests at 2:1 and 6:1 loading ratios with the fabric oriented with the filling yarns in the master cylinder direction of the biaxial tester. The test results obtained would show that the filling load elongation diagrams approach the uniaxial filling load-elongation diagram with increasing loading ratio.

The shape of curve number 3 in Figure 6 departs from that of the other curves at the lower loads. Since some filling yarn bowing and skewing was present in the polyurethane-coated nylon fabric, this could account for peculiarities in the load-elongation diagrams at low load levels.

The individual results of six tests performed on the polyurethane-coated nylon fabric at a 1:1 loading ratio are given in Figure 7 and at a 6:1 loading ratio in Figure 8. As shown, the agreement among the tests is generally quite good. The differences are believed to be mainly due to variation in fabric response and not to testing errors.

The last experimental points in Figures 5 through 8, the points at the highest strain, were recorded in most instances at the last elongation increment before the test specimen failed. However, the load corresponding to this elongation level cannot be considered to approximate the true breaking strength of the fabric under biaxial loading. Stress concentrations occur where the tails join the biaxially stressed central portion of the cruciform test specimens and cause premature failure.

The results of 1:1 loading ratio biaxial tests performed with the new AMC biaxial tester, the older MRD* biaxial tester built for the U. S. Air Force, and the inflated disc biaxial tester** on the polyurethane-coated nylon fabric are given in Figure 9. As shown, there are considerable differences among the results obtained with the three instruments. However, since the test specimens evaluated

*Davidson, D. A., "The Mechanical Behavior of Fabrics Subject to Biaxial Stress: Canal-Model Theory of the Plain Weave" ML-TDR-64-239, Air Force Materials Laboratory, July 1964.

**The inflated disc biaxial tests were performed at the U. S. Army Natick Laboratories.

on the three testers were not taken from the same roll of fabric, and the variation in fabric properties from roll to roll is not known, no definitive conclusions as to the cause of the differences can be formulated.

Average load-elongation diagrams of the polyurethane-coated nylon fabric (at a loading ratio of 2:1) obtained with the new biaxial tester, the MRD instrument, and an inflated cylinder tester are compared in Figure 10. The inflated cylinder tests were performed by the U. S. Army Natick Laboratories. As shown, there is good agreement between the tests obtained with the new biaxial tester and the inflated cylinder tester. However, as was the case for the results presented in Figure 9, definitive conclusions are not possible, since the test specimens evaluated on the three instruments were not necessarily taken from the same roll of fabric.

The average load-elongation diagrams in the warp and filling directions of the 18.3-oz/sq yd, vinyl-coated nylon fabric at loading ratios of 1:1, 2:1, and 6:1 are given in Figure 11 and similarly for the 13.8-oz/sq yd neoprene- and Hypalon-coated polyester fabric in Figure 12. The average warp and filling uniaxial load-elongation diagrams are also given in these figures. As discussed previously, considerable filling yarn bowing and skewing was evident in these two fabrics. The load-elongation diagrams obtained are undoubtedly quite different from those that would be obtained with similar fabric evidencing no yarn bow or skew. Bowed test specimens probably exhibit higher elongations at a given load and lower rupture loads due to unequal load sharing among yarns.

The biaxial tests of the two heavier-weight fabrics were not continued to rupture. The usual service loading of these fabrics is only a small fraction of their rupture load. Therefore, in order to obtain more precise measurements in the lower load range, the biaxial tester force system was set so that the maximum full-scale load was 50 lb/inch of fabric width. The applied load was increased up to this level, then released, and the test terminated.

The photoelectric strain-measuring system was used to obtain all test results shown in Figures 4 through 12 using the new biaxial tensile tester except where otherwise noted in the figures. A photographic strain-measuring system was used in tests performed on the MRD biaxial tester.

Figure 11 includes data for tests performed at a 2:1 loading ratio using both the photoelectric and photographic strain-measuring systems. As shown, there is a large difference between the elongations indicated by these two methods of strain measurement. These differences appear to be due to a non-uniform biaxial force field which is a result of the severe bowing of the filling yarns in the fabric. The strain gauge is linked to the fabric with two needle points spaced one-quarter inch apart. During the test, the strain gauge exhibited a rotational movement caused by the difference in fabric extension at the two needle point locations.

CONCLUSIONS

The AMC biaxial stress-strain instrument built by the Fabric Research Laboratories is suitable for measuring the biaxial stress-strain response of fabrics used for spherical shelters 1:1 biaxial stress-strain ratio and for cylindrical shelters 1:2 biaxial stress-strain ratio. A good correlation exists between the photographic strain-measuring system and the photoelectric strain-measuring system. The testing machine is not suitable for measuring the mechanical response of a fabric at different loading speeds (rate of loading). The speed range is too small to yield significant results.

TABLE I

DESCRIPTION OF COATED FABRICS

	Polyurethane-Coated Nylon Fabric	Vinyl-Coated Nylon Fabric	Neoprene- and Hypalon-Coated Polyester Fabric
Yarn material	nylon	nylon	polyester
Coating material	polyurethane	vinyl	neoprene (base coat) Hypalon (finish coat)
Specification		MIL-C-43086	MIL-C-43285, -43286
Pick and end count	55 ends/inch x 104 picks/inch	28 ends/inch x 28 picks/inch	33 ends/inch x 35 picks/inch
Weight	2.6 oz/sq yd	18.3 oz/sq yd	13.8 oz/sq yd
Color	orange	white	gray and white

TABLE II

UNIAXIAL TENSILE PROPERTIES OF COATED FABRICS

Material	Tester	Rupture Elongation (%) Warp	Rupture Elongation (%) Filling	Rupture Load (lb/inch width) Warp	Rupture Load (lb/inch width) Filling
Polyurethane-coated nylon	Instron*	21.9	40.2	53.6	33.0
		22.3	32.9	53.0	23.4
		22.9	42.9	54.4	33.2
		24.8	38.3	56.2	32.3
		27.6	44.9	55.9	33.7
		(23.9)	(39.8)	(54.4)	(31.1)
	New AMC Biaxial Tester**	19.5	34.0	46.5	34.0
		23.0	35.5	50.4	33.0
		20.0	50.2	49.3	33.1
		21.5	34.8	50.2	32.0
		(21.0)	(34.0)	(49.3)	(33.1)
Vinyl-coated nylon	Instron*	25.9	32.1	361	358
		27.5	32.7	356	331
		26.5	32.9	356	366
		30.5	32.3	393	366
		25.9	30.2	358	321
		(27.3)	(32.0)	(365)	(348)
Neoprene- and Hypalon-coated polyester	Instron*	19.0	29.1	199	196
		19.3	31.9	202	207
		19.4	28.5	208	168
		17.0	30.3	188	204
		16.8	27.5	193	184
		(18.3)	(29.5)	(198)	(192)

*The testing on the Instron was performed using a 4-inch gauge length, 5% per minute strain rate and serrated jaws.

**The testing on the new AMC biaxial tester was performed using a 2-inch gauge length and a 4-inch sample width. The average strain rate in the warp direction was 4.9% per minute and in the filling direction, 18.8% per minute.

NOTE: Figures in parentheses are averages.

TABLE III

BIAXIAL TEST DATA OF POLYURETHANE-COATED

NYLON FABRIC AT A LOADING RATIO OF 1:1

Elongation (%)	Load (lb)	Load (lb/inch width)
0	0	0
2	1.3	0.3
4	4.1	1.2
6	8.0	2.0
8	12.5	3.1
10	17.7	4.4
12	22.8	5.7
14	28.6	7.2
16	35.7	8.9
18	42.8	10.7
20	51.0	12.8
22	60.9	15.2
24	71.0	17.8
26	84.2	21.0
28	98.3	24.6

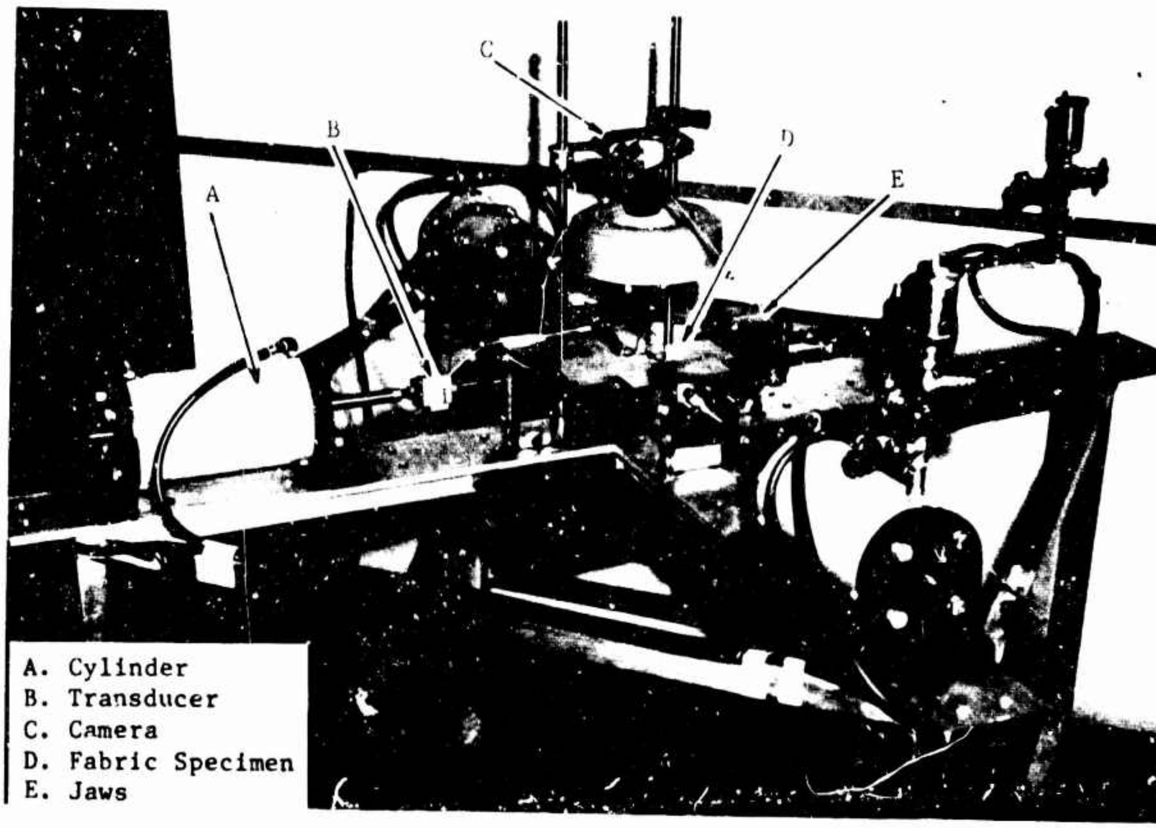

Figure 1. New AMC Biaxial Tensile Tester.

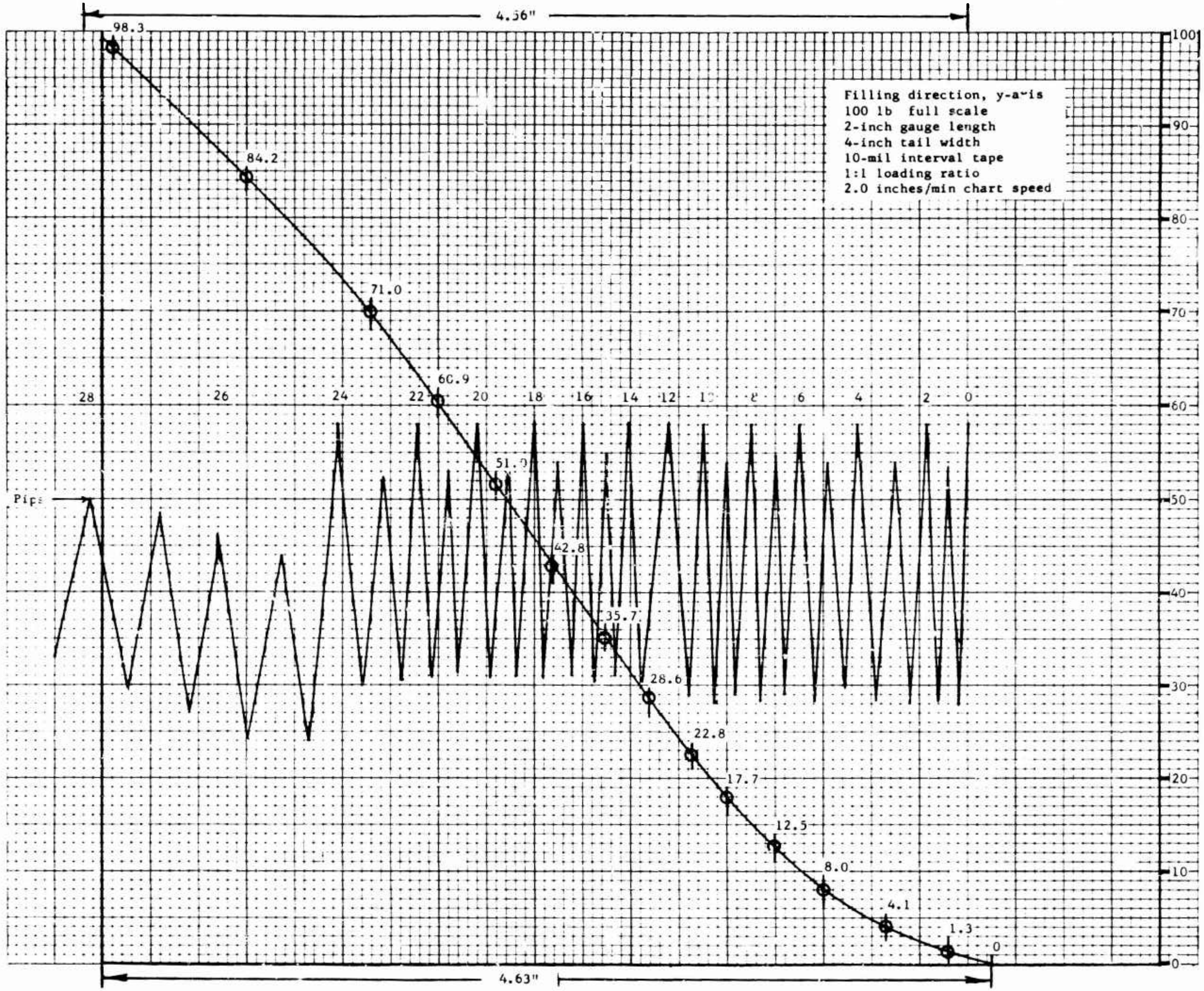

Figure 2. Autographic Load and Elongation Data Recorded During a Biaxial Tensile Test.

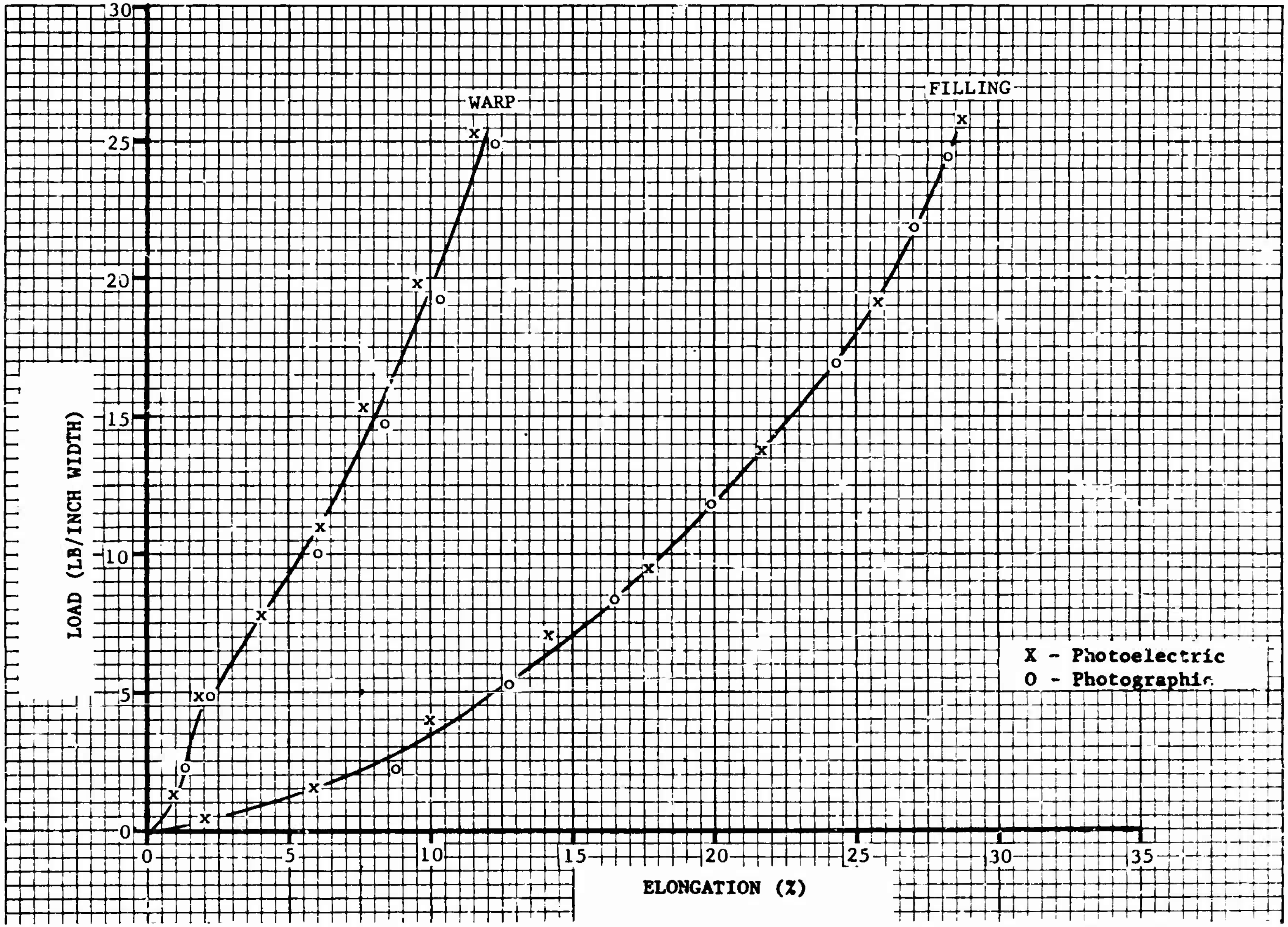

Figure 3. Comparison of the Photoelectric and Photographic Strain-Measuring Systems Using the Polyurethane-Coated Nylon Fabric and a 1:1 Loading Ratio.

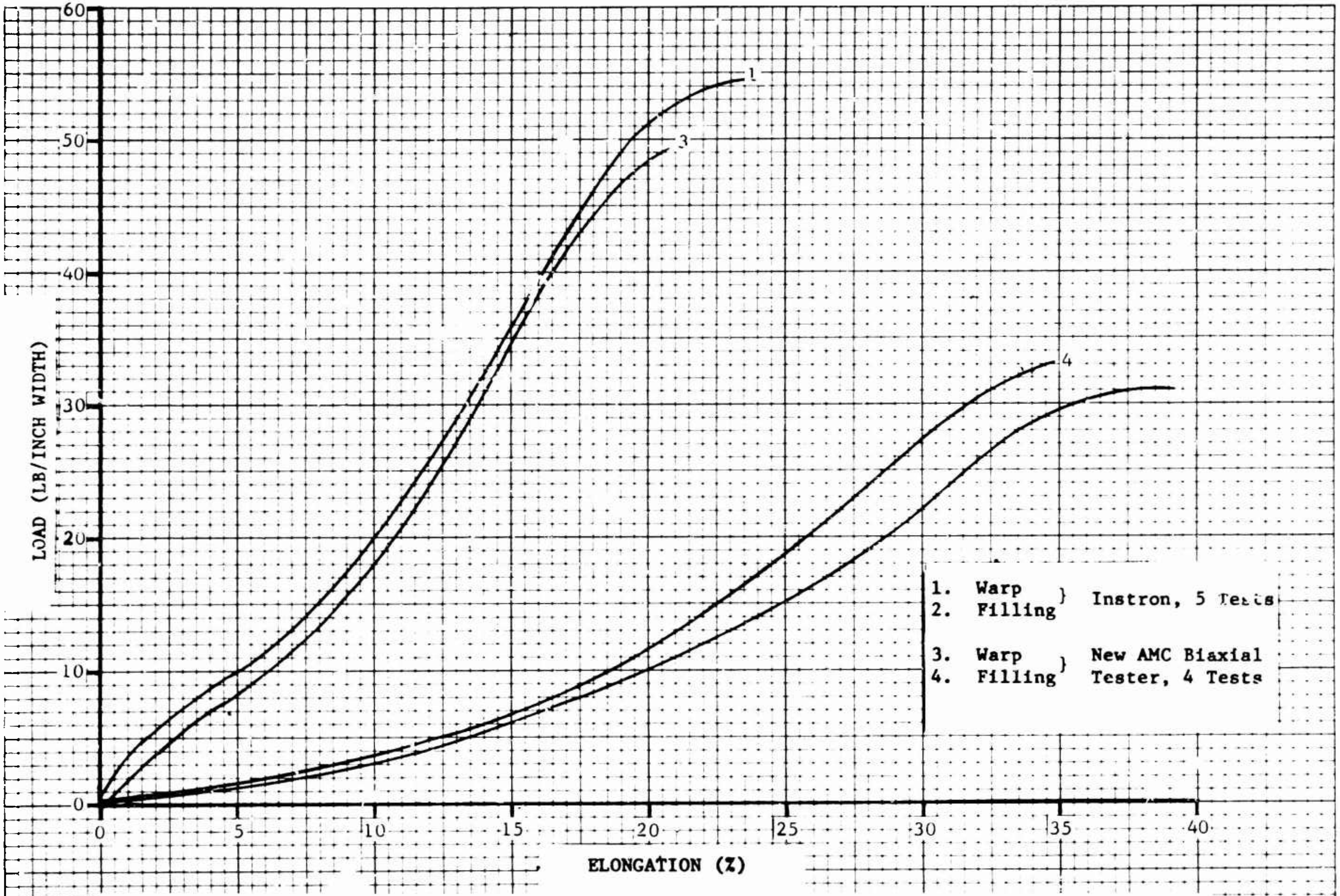

Figure 4. Comparison of Average Uniaxial Load-Elongation Diagrams of Polyurethane-Coated Nylon Fabric.

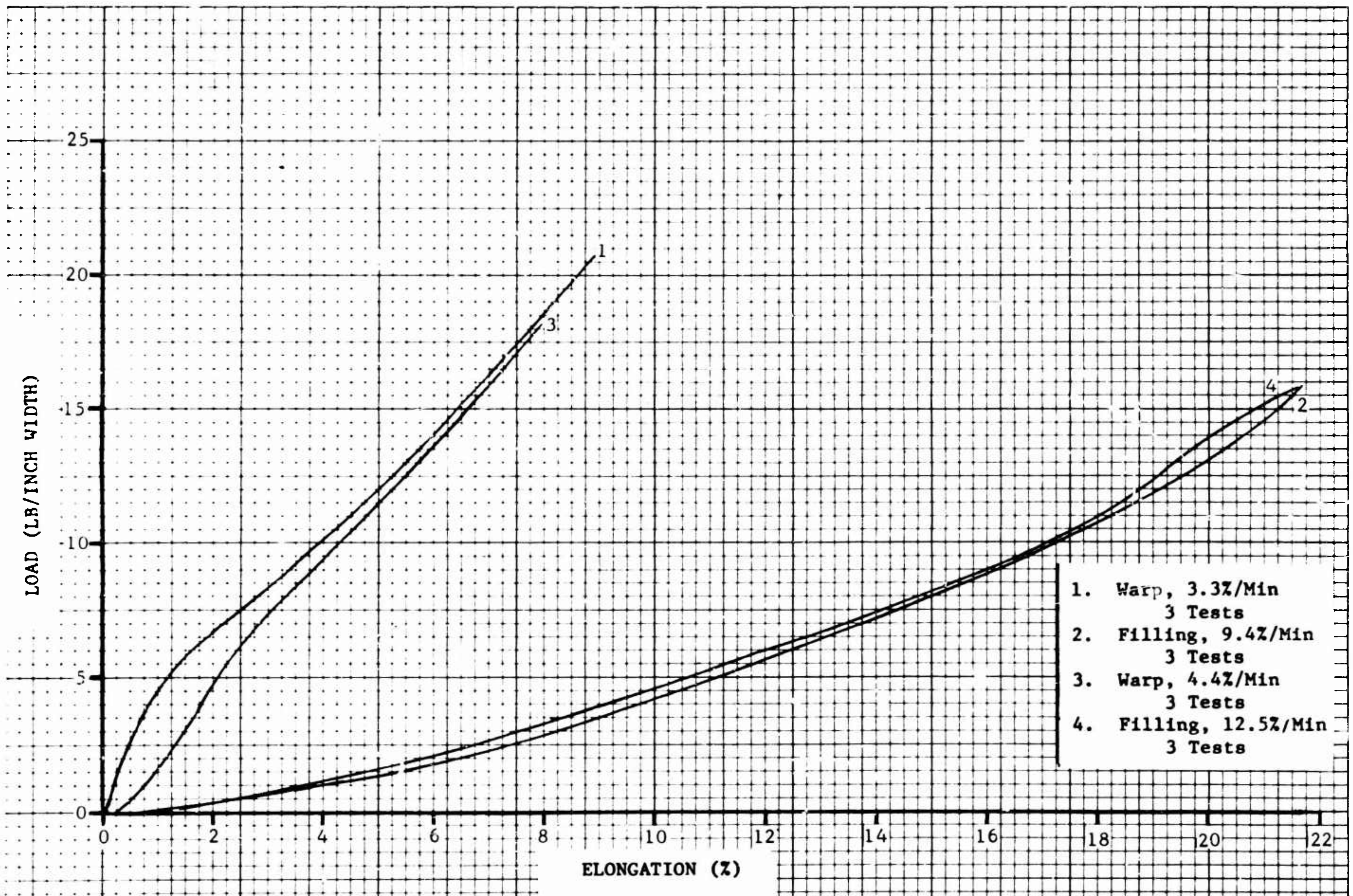

Figure 5. Average Biaxial Load-Elongation Diagrams of Polyurethane-Coated Nylon Fabric at a 1:1 Loading Ratio.

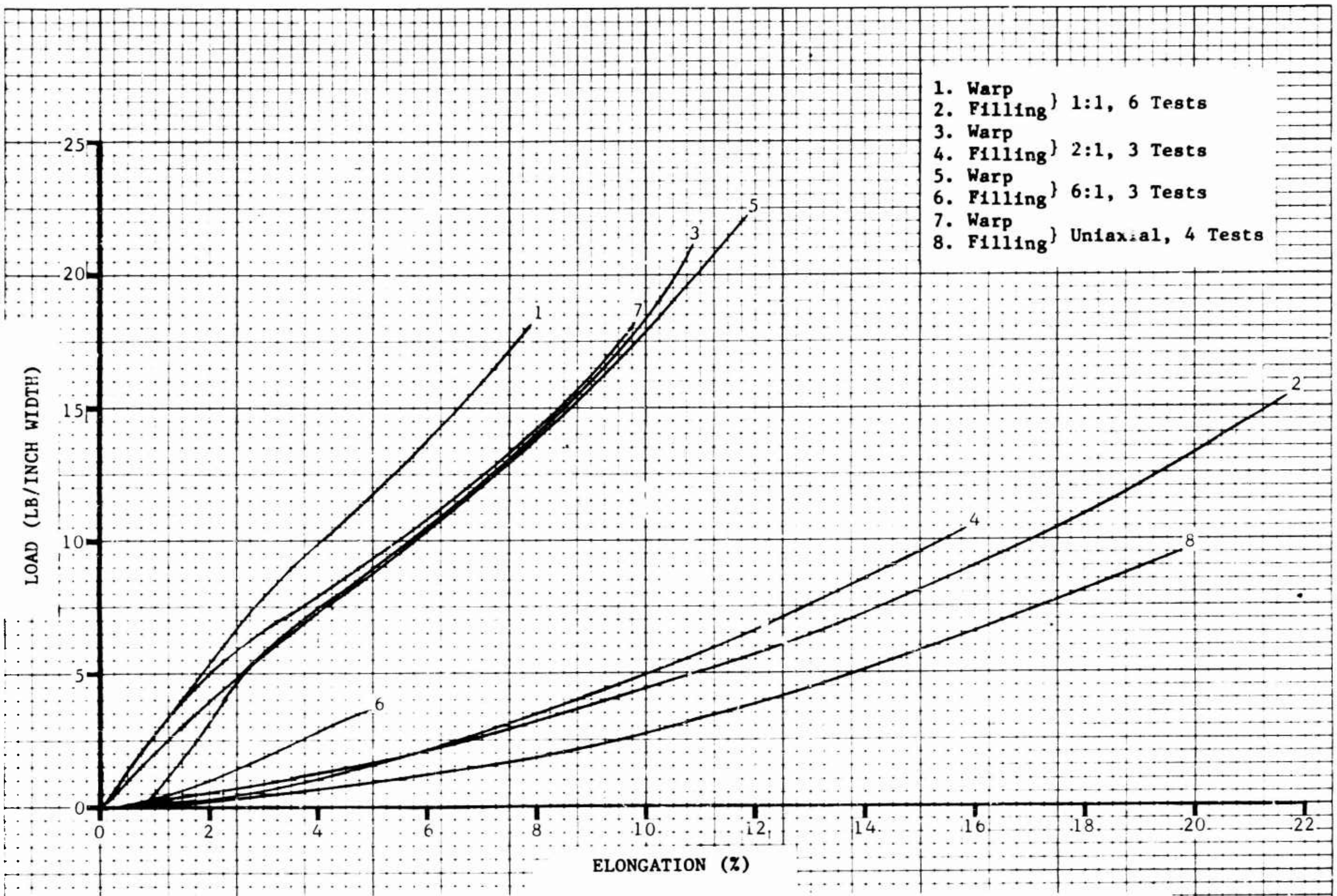

Figure 6. Average Biaxial and Uniaxial Load-Elongation Diagrams of Polyurethane-Coated Nylon Fabric at Various Loading Ratios.

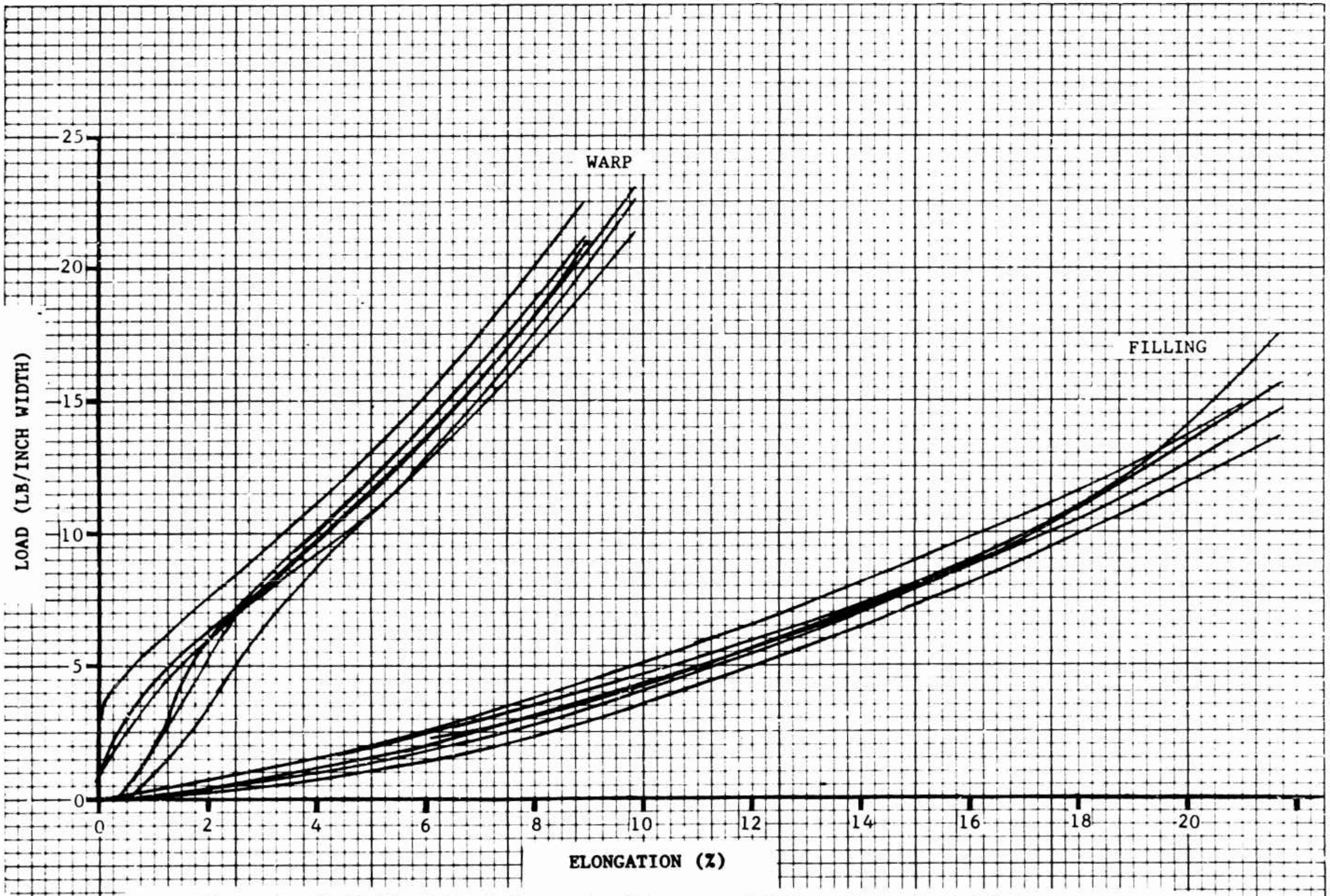

Figure 7. Individual Load-Elongation Diagrams of Polyurethane-Coated Nylon Fabric at a 1:1 Loading Ratio.

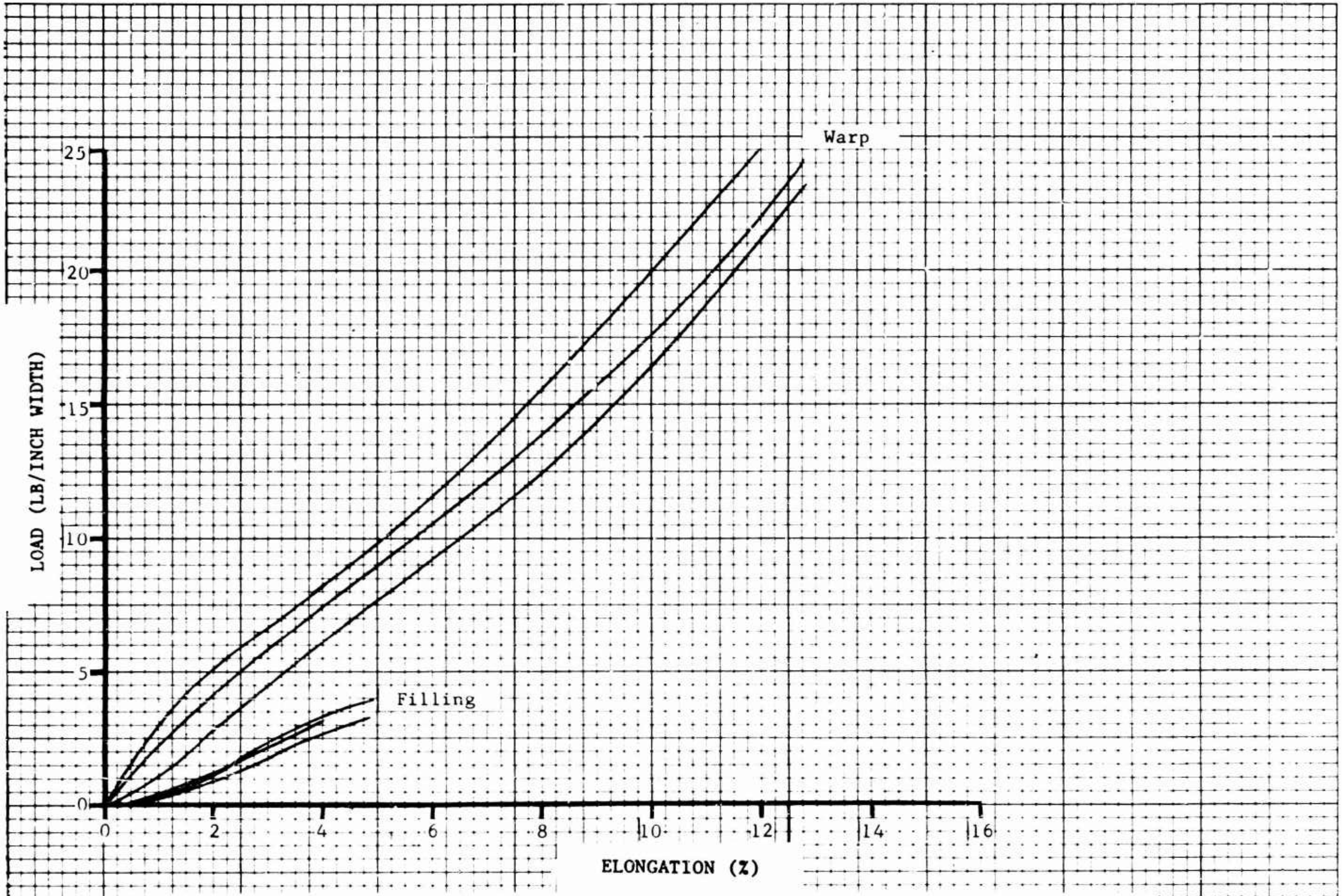

Figure 8. Individual Load-Elongation Diagrams of Polyurethane-Coated Nylon Fabric at a 6:1 Loading Ratio.

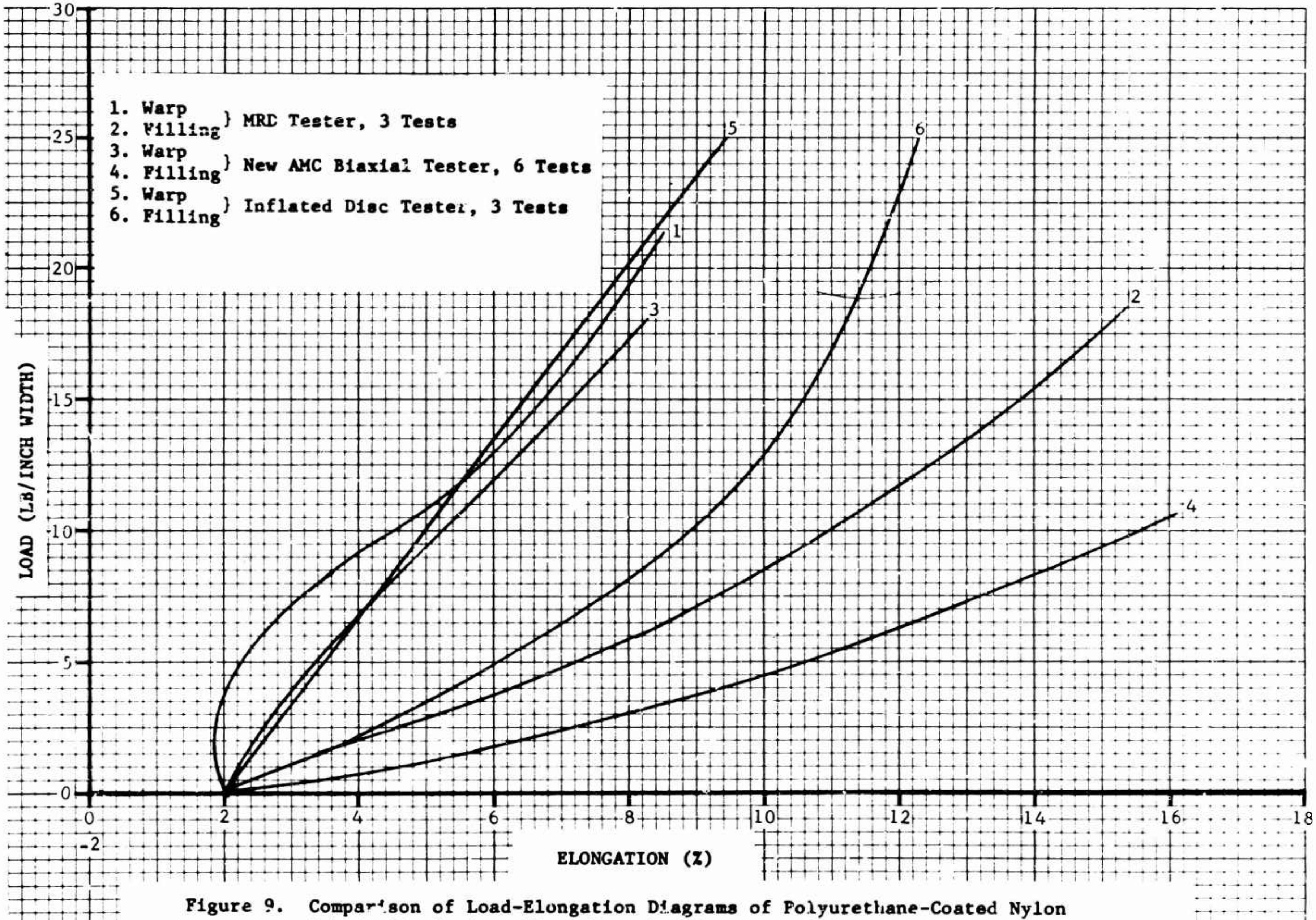

Figure 9. Comparison of Load-Elongation Diagrams of Polyurethane-Coated Nylon Fabric Obtained on Three Test Machines at a 1:1 Loading Ratio.

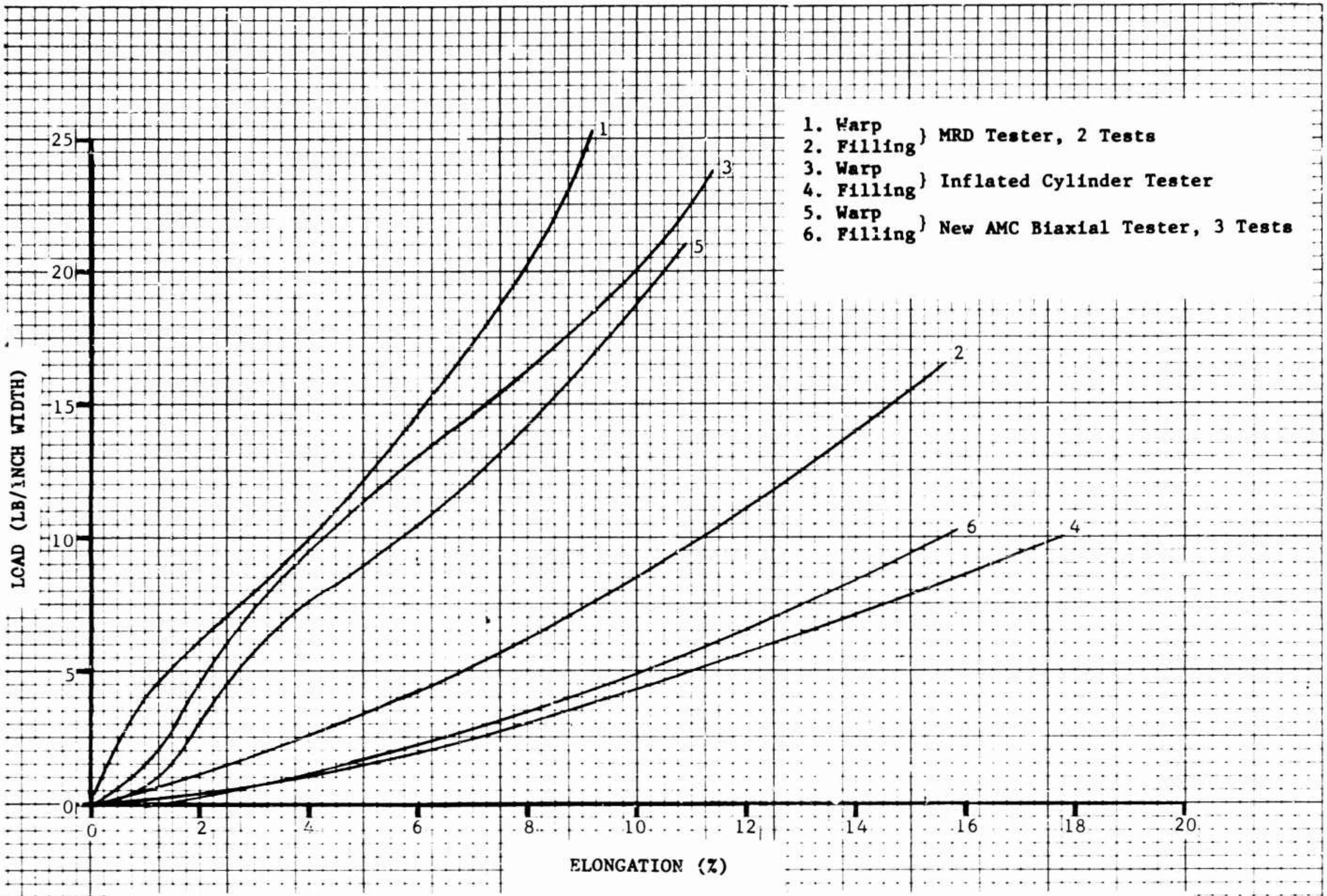

Figure 10. Comparison of Load-Elongation Diagrams of Polyurethane-Coated Nylon Fabric Obtained on Three Test Machines at a 2:1 Loading Ratio.

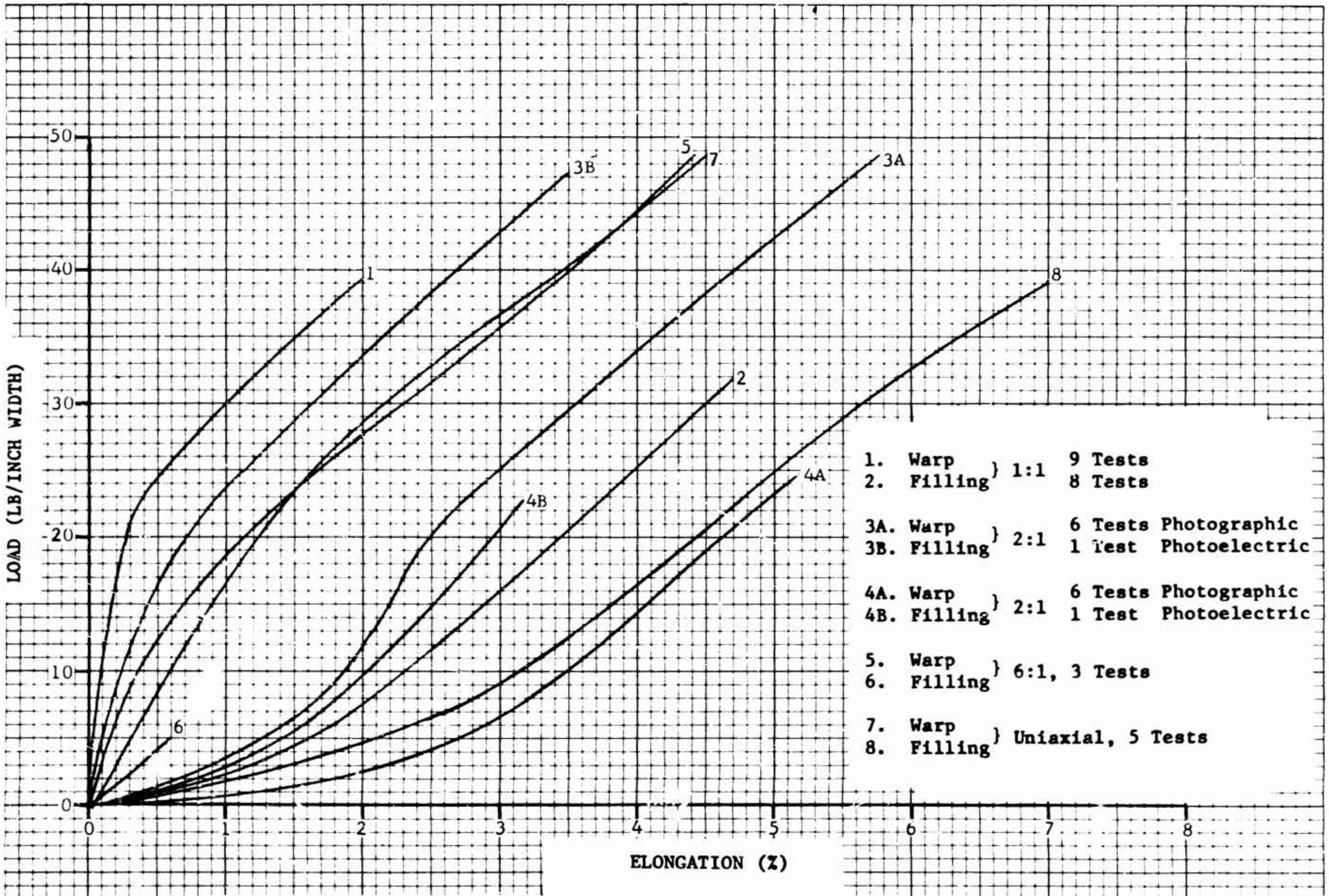

Figure 11. Average Load-Elongation Diagrams of Vinyl-Coated Nylon Fabric at Various Loading Ratios.

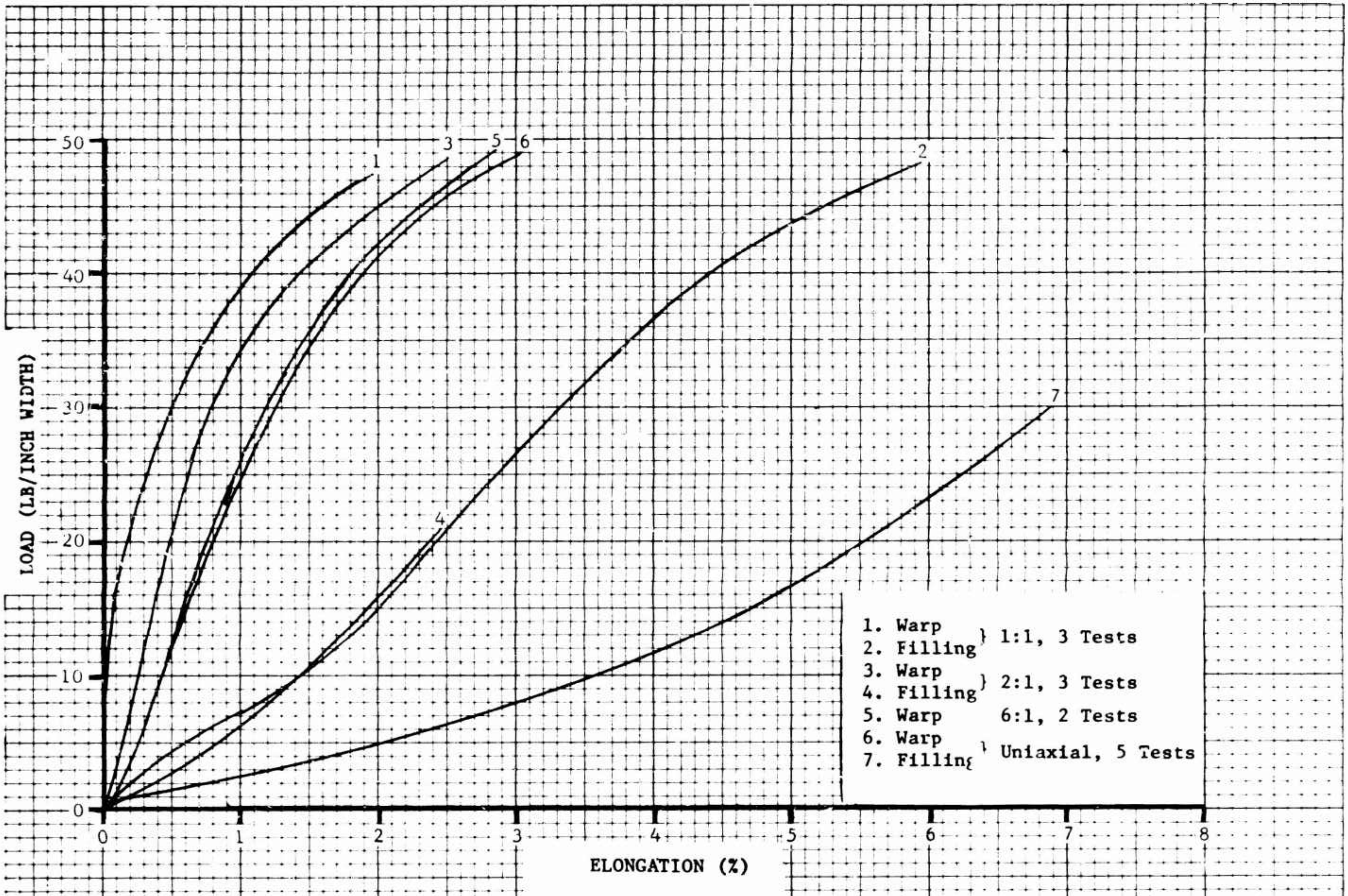

Figure 12. Average Load-Elongation Diagrams of Neoprene- and Hypalon-Coated Polyester Fabric at Various Loading Ratios.

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(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

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13. ABSTRACT

This report discusses the design, operation, and purpose of a new biaxial test instrument that was constructed by the Fabric Research Laboratories of Dedham, Massachusetts, for the U. S. Army Natick Laboratories, a subordinate activity of the U. S. Army Materiel Command.

The report also presents the stress-strain test results on three air-supported tent fabrics performed with the new test instrument. A correlation and comparison is made between these data and previous work performed with other tensile test equipment.

The AMC biaxial test instrument was found to be suitable for measuring the mechanical response of fabrics under a biaxial load ratio of 1:1, as in spherical air-supported structures, and a biaxial load ratio of 1:2, as in cylindrical air-supported structures.

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Test equipment	8					
Tests	8					
Biaxial stresses	9		8,9			
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